# APPENDIX A

## JUDGMENTS AND DECISIONS

### Judgment of the District Court

IN THE UNITED STATES DISTRICT COURT
FOR THE WESTERN DISTRICT OF TEXAS
SAN ANTONIO DIVISION

Civil Action No. 3633

BECKMAN INSTRUMENTS, INC. and LELAND C. CLARK, JR.,
*Plaintiffs,*

v.

CHEMTRONICS, INC. and J. RYAN NEVILLE,
*Defendants.*

**Judgment**

(Filed: Dec. 30, 1968)

Came on to be heard the above cause before the Court, and the Court having heard the evidence and the parties having submitted briefs thereafter and proposed Findings of Fact and Conclusions of Law, and having considered same is of the opinion that the Clark Patent is valid and that the Neville Patent is valid and that the Neville Patent does not infringe the Clark Patent, and that Plaintiffs were not guilty of fraud in obtaining the Clark Patent and that neither party is entitled to damages from the other, and that the following judgment should be and hereby is entered;

IT IS THEREFORE ORDERED, ADJUDGED AND DECREED that the Clark Patent held by the Plaintiffs be and hereby is declared to be valid and the Neville Patent held by the Defendants be and hereby is declared to be valid;

IT IS FURTHER ORDERED, ADJUDGED AND DECREED that the Plaintiffs take nothing by their suit for damages against the Defendants; IT IS FURTHER ORDERED, ADJUDGED AND DECREED that the Defendants take nothing by their suit for damages against the Plaintiffs.

IT IS FURTHER ORDERED, ADJUDGED AND DECREED that all the relief asked by all parties not herein specifically granted or denied is DENIED, and that the costs incurred by each party shall be borne by each party.

ENTERED this 27 day of December, 1968.

/s/
UNITED STATES DISTRICT JUDGE

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## Findings of the District Court

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IN THE UNITED STATES DISTRICT COURT
FOR THE WESTERN DISTRICT OF TEXAS
SAN ANTONIO DIVISION

Civil Action No. 3633

BECKMAN INSTRUMENTS, INC. and LELAND C. CLARK, JR.,
*Plaintiffs,*

v.

CHEMTRONICS, INC. and J. RYAN NEVILLE,
*Defendants.*

## Findings of Fact and Conclusions of Law

(Filed: Dec. 30, 1968)

1. This is a patent infringement suit arising under the Patent Laws of the United States, and this Court has jurisdiction over the parties and the subject matter of this civil action.

2. The patent in suit was granted to plaintiff Leland C. Clark, Jr., on November 17, 1959 upon an application Ser. No. 573,029 filed March 21, 1956.

3. Plaintiff Clark entered into an agreement on October 23, 1956 under the terms of which plaintiff Beckman Instruments, Inc. was granted an enclusive license under the patent in suit as well as the right to grant sub-licenses to others. Beckman has granted sub-licenses to seventeen companies.

4. Dr. Clark received the degree of Doctor of Philosophy from the University of Rochester in Rochester, New York, in 1944 and then went to Antioch College in Yellow Springs, Ohio, to take charge of a biochemistry program at the Fels Research Institute, where he became Director of the Biochemistry Laboratory. The program pertained particularly to the chemistry of child development and involved setting up a laboratory to do blood, urine and vitamin determinations, etc. In the course of time he became vitally interested in the development of a large number of projects.

5. In many of these projects the oxygen content of a substance was of interest, both scientifically and clinically. During the period between about 1949 and 1956, preceding his making of the invention in suit, he had experimented with various known techniques for the measurement of oxygen in fluids, but found that none of them was satisfactory. Consequently he began to work to devise an instrument which would function satisfactorily to measure blood oxygen, or "oxygen tension". His work centered about a polarographic device, an electrochemical cell comprising a cathode, an anode, and an electrolyte connecting the two. If a carefully selected voltage is applied across the electrodes, the cathode becomes polarized. That is to say, its surface becomes covered with what may be visualized as a layer of electrons, and no current flows. If the cathode is now exposed to a medium containing oxygen,

oxygen molecules reach the cathode and each molecule removes four electrons. Then there is a chemical reaction as the result of which water is formed, and the oxygen, as such, is consumed. As the result of the removal of electrons from the cathode by the oxygen molecules, the cathode becomes depolarized and current flows. The rate at which the electrons are removed from the cathode is directly dependent upon the number of oxygen molecules in the medium being measured and the rate at which they reach the cathode. Consequently the magnitude of the current is a measure of the amount of oxygen in the medium to be measured.

6. While the essential process seems rather simple, in practice there were very difficult problems. Perhaps the most difficult problem arises from the fact that if the cathode is dipped in a liquid such as blood, it rapidly becomes "poisoned" by the accumulation of various substances on its surface which block and eventually stop the polarographic activity. Moreover, a bare cathode dipped in a liquid is extremely sensitive to any motion of the liquid with respect to the cathode, and the motion (which is almost inevitable), introduces a large error in the measurement.

7. In an attempt to overcome these difficulties, Dr. Clark tried many schemes with various degrees of success, including in particular the use of implanted electrodes, both bare and cellophane covered, which proved useful for measuring oxygen changes in animal brain tissue, and the use of a cellophane covered cathode (negative electrode) which proved useful in measuring blood oxygen in the operation of the heart-lung machine.

8. On October 4, 1954 Dr. Clark was sitting on a bench while on a visit to Columbus and it occurred to him that the measurement of oxygen could be much better made if he put *both* the anode and the cathode behind a membrane which was not permeable to ions but which would permit the passage of oxygen. He rushed home to his laboratory

and constructed a completely successful polarographic device for measuring oxygen, the device shown and described in the patent in suit, Exhibit 1. As will be seen the instrument is organized within a hollow tube 10 within which is disposed an insulating rod 15, usually of glass, held upright within the tube by a pair of washers 16 and 18. Through the center of the insulating rod 15 there is a thin wire 22 leading to a small button 20 of platinum mounted in the lower end of the rod 15, the surface of the button being flush with the bottom of the rod 15. Around the outer surface of the bottom portion of the rod 15 there is a coating 26 of electrically conductive material such as silver or silver-chloride. A membrane 35 of a material such as polyethylene is stretched across the lower end of the tube 10 and is secured in place by an O-ring seal 36 contained in a lower cap member 38 slipped over the lower portion of the tube 10. The tube is partially filled with an electrolyte solution indicated at 32, the electrolyte being generally a salt solution such as sodium chloride or the like.

9. This arrangement provides a very thin film of electrolyte solution interposed between the inner surface of the membrane 35 and the cathode 20. As the patent explains, a battery is employed to provide a source of voltage, and the circuit is schematically represented in Fig. 2. This circuit is similar to that appearing in Fig. 3 of the patent but slightly modified for purposes of clarity.

10. The plaintiff Clark conceived the invention of the patent in suit and reduced it to practice on October 4, 1954, on which day he constructed and tested a cell designed in accordance with the disclosure of the patent in suit.

11. The medical profession had for years been acutely interested in devising some means by which the oxygen content of blood could be measured both easily and accurately, and many workers had devised various devices and systems for that purpose, none of which had proved entirely satisfactory. The plaintiff Clark first divulged

his invention at a scientific meeting held in Atlantic City in 1956, the meeting having been specifically convened by Dr. John W. Severinghaus for the purpose of discussing the problem of oxygen measurement and endeavoring to discover a better device for the purpose. The announcement of his invention by Dr. Clark was hailed by scientists, not only in the United States but in foreign countries as presenting the first satisfactory device for the measurement of oxygen in gases as well as liquid, as is shown by a large number of scientific publications offered in evidence, as well as by the deposition of Dr. Severinghaus.

12. Defendants allege either that the invention of the patent in suit was anticipated by prior art (35 USC 102) or that the invention of the patent in suit would have been obvious to one skilled in the art at the time the invention was made (35 USC 103). On these issues both parties presented the testimony of experts. In addition to the deposition testimony of Dr. Severinghaus, plaintiffs presented the testimony of Professor David N. Hume of Massachusetts Institute of Technology and of Professor Donald T. Sawyer of the University of California at Riverside. Defendants presented the testimony of Professor Allen J. Bard, of the University of Texas. Upon consideration of the testimony and exhibits it is found that the prior art relied upon by defendants does not anticipate the invention of the patent in suit; moreover, after careful factual inquiry, as directed by the Supreme Court in *Graham* v. *John Deere Co. of Kansas City*, 383 US 1, 15 Law Ed. 2d 545 (1966), it is found that the level of skill in the art to which the patent relates is high and that the invention of the patent in suit would not have been obvious to one skilled in the art in October 1954, when the invention was made by Dr. Clark. The factual situation is analogous to that considered by the Supreme Court in *United States* v. *Adams*, 383 US 39, 15 Law Ed. 2d 572 (1966).

13. Specifically the defendants rely on the disclosure in the article published by Dr. Clark in 1953 and the prior

work of Dr. Stow and the Abstract of it published in December of 1954. A fundamental concept of the patent in suit is the combination of an anode, a cathode and an electrolyte, of a polarographic cell located behind a membrane so that the electric current between the anode and the cathode flows through the electrolyte completely isolated from the medium containing the oxygen to be measured.

14. In the cell described in the 1953 paper of Dr. Clark only the cathode was covered with a membrane, there was no disclosure of putting either an electrolyte or an anode behind the membrane; and the path of the current flow was from the cathode *through* the membrane, through the medium in which the oxygen is to be measured to the anode.

15. The device of Stow utilized a glass electrode for the purpose of measuring pH, or acidity. This is essentially a voltage or potentiometric measurement and not a current or polarographic measurement. It was described as utilizing distilled water (which is not an electrolyte) behind a rubber membrane in contact with the glass electrode, and operated on the establishment of carbon dioxide equilibrium on both sides of the membrane. Since the presence of carbon dioxide in the distilled water forms an acid, the measurements of this acidity gave an indication of the amount of carbon dioxide present. The Stow device does not and cannot permit the flow of any significant current.

16. Defendants, in addition to the Stow device and the 1953 Clark article, also relied upon other prior art publications, an article by Olsen and Schroeder and an article by Tobias. The devices described in these articles have no membrane and therefore do not remotely suggest the novel combination of the Clark patent in suit. The objective evidence in the record clearly establishes that the device of the Clark patent was in fact not obvious to those skilled in the art. It is therefore concluded that the Clark patent in suit is valid.

17. Defendants allege that plaintiffs were guilty of practicing fraud on the Patent Office because defendants did not call the attention of the Patent Office to the prior device of Stow or to the 1953 publication by Dr. Clark, both of which are referred to in previous findings. Inasmuch as the Clark patent in suit in determined to be valid and represent a patentable invention over the prior art of Stow and Clark, it follows logically that plaintiffs were under no obligation to disclose to the Patent Office prior art which would not have been effective to invalidate the patent. To be successful defendants would have had to establish that the Patent Office would not have granted the Clark patent in suit, if the Patent Office had knowledge of the prior Clark publication and the Stow prior device. Since it has been established that the Clark patent defines a patentable invention, it follows that no case of fraud has been made out.

18. In order to establish fraud it would have been necessary for defendants to prove that plaintiffs deliberately and in bad faith withheld from the Patent Office knowledge of the prior Clark and Stow work. The record does not support any finding of bad faith on the part of the plaintiffs.

19. In view of the finding that plaintiffs were not guilty of fraud on the Patent Office, it must follow that defendants' counterclaim must be dismissed, since it is founded entirely on the contention that as the result of the alleged fraud the patent was illegally procured and that exploitation of the patent by plaintiffs represented the exertion of an illegal monopoly.

20. Defendants' oxygen-sensing cell is a galvanic cell accomplishing galvanic analysis and uses a cadmium auxiliary electrode and a gold sensing electrode located behind a permeable membrane. Defendants' device is self-energized, and does not require an impressed potential as does the Clark patented cell.

21. In 1955 before Clark had ever disclosed his invention to the public or filed his application, Defendant Neville was confronted at the Brooks School of Aerospace Medicine with the problem of hypoxia and the problems it caused with aviators. Although he had just graduated from Stanford with a Ph.D. in physiology, Dr. Neville studied the prior art, and immediately constructed a successful oxygen sensing cell having two electrodes behind a permeable membrane. This cell employed mercury electrodes and was not self-energized.

22. From 1955 to 1957 Defendant Neville undertook a development program to develop an oxygen-sensing device for use in aviators' masks. This development program resulted in the development of several devices including the accused device, and the work was done independently of any knowledge of the Clark invention. Defendant Neville in this work referred to the prior art of Tobias and Clark's 1953 article. There is no evidence that Defendants in any way copied or imitated Plaintiffs' patented device.

23. Defendants also manufactures a self-energized carbon dioxide sensing device which utilizes a glass indicating electrode and a silver reference electrode behind a permeable membrane of polyethylene. This device is similar to the self-energized carbon dioxide sensor of Stow.

24. The electrode materials in a galvanic cell such as Defendants' oxygen-sensing device must be carefully selected so that the cell is operating on a plateau on the current voltage curve. The type of analysis carried out in such a cell is termed galvanic analysis as opposed to amperometric or polarographic analysis wherein a potential is impressed upon the cell as in the Clark patented cell.

25. If a potential were impressed on the accused oxygen-sensing device, a voltage-current curve would result which is different from that obtainable with the Clark patented

device. The Clark patented cell will produce a spontaneous voltage, without an impressed potential across the electrodes, but operating in this manner it is not a reliable instrument useful for making analytical measurements.

26. Defendants' oxygen-sensing cell is not a polarographic cell in any respect, and does not accomplish polarographic analysis. According to accepted definition, the term "polarographic" refers to a technique for recording or determination of current and potential characteristics simultaneously of an indicator microelectrode, this microelectrode being a dropping mercury electrode immersed in a solution. If the term "polarographic" or its variants are defined so as to cover Defendants' galvanic oxygen-sensing cell, the terms are rendered indefinite.

27. The Clark patent contains no disclosure teaching one skilled in the art to make a self-energized oxygen-sensing cell such as the one accused.

28. Defendants' oxygen-sensing galvanic cell uses a cadmium auxiliary electrode which is not a reference electrode within the meaning of the patent.

29. Defendants' oxygen-sensing cell is not similar or equivalent to the patented Clark cell as disclosed, and there is no substantial identity of means, operation, or result between the accused oxygen-sensing cell and the patented Clark cell. Galvanic analysis is not equivalent to polarographic analysis.

30. Plaintiffs distinguished prior art before the Patent Office on the ground that the art involved a self-energized cell.

31. Defendant Neville is the owner of United States Patent 3,071,530 on the accused oxygen-sensing device, which was allowed by the Patent Office over the Clark patent in suit. The cell illustrated in the Neville patent 3,071,530 is a self-energized cell which is virtually identical to the accused structure. The invention of the Neville

patent was not obvious to a person of ordinary skill in the art.

32. To prove infringement the patentee must compare the accused structure with the patented structure as disclosed in the specifications and drawings, and he must prove substantial identity of means, operation and result. *Foster Cathead Co.* v. *Haisha*, 382 F.2d 761, 155 U.S.P.Q. 177 (5th Cir. 1967); *McCutchen* v. *Singer Co.*, 386 F.2d 82, 156 U.S.P.Q. 33 (5th Cir. 1967). Plaintiffs have not only failed to carry this burden, the proof is to the contrary. The patent does not disclose a self-energized cell, the accused devices are self-energized, and the Patent Office must have recognized the distinction when it granted Neville a patent on the accused device in spite of the Clark patent. *McCutchen* v. *Singer Co.*, *supra*.

33. A patent claim cannot, like "a nose of wax," be twisted one way to avoid anticipation and another way to find infringement. *White* v. *Dunbar*, 119 U.S. 47 (1886); *Permo* v. *Hudson-Ross*, 179 F.2d 386 (7th Cir. 1950); and claims should be construed, if possible, to uphold their validity. *Automatic Devices Corp.* v. *Sinko Tool & Mfg. Co.*, 112 F. 2d 335, 340 (7th Cir. 1940), aff'd. 314 U.S. 94, 62 S.Ct. 42, 86 L. Ed. 65 (1941); *Dominion Magnesium Ltd.* v. *United States*, 320 F. 2d 388, 394 (Ct. Cl. 1963). If the claims of the Clark patent were construed to cover the accused self-energized devices, the claims would also cover the prior art self-energized device of Stow. Thus, the claims of the Clark patent must be construed as limited to polarographic analysis in order to be valid.

34. Neither of the self-energized cells of Defendants is within any valid scope of the Clark invention or the Clark patent, and hence there is no infringement of the Clark patent by Defendants.

35. The Neville patent 3,071,530 is valid.

s/
UNITED STATES DISTRICT JUDGE

## Judgment of the Court of Appeals

UNITED STATES COURT OF APPEALS
FOR THE FIFTH CIRCUIT

OCTOBER TERM, 1969

No. 27412

D. C. Docket No. Civ. 3633

BECKMAN INSTRUMENTS, INC., and
LELAND C. CLARK, JR.,
*Plaintiff-Appellants-Cross-Appellees,*

v.

CHEMTRONICS, INC. and J. RYAN NEVILLE,
*Defendants-Appellees-Cross-Appellants.*

*Appeal from the United States District Court for the Western District of Texas*

Before GEWIN, THORNBERRY and AINSWORTH, Circuit Judges.

### Judgment

This cause came on to be heard on the transcript of the record from the United States District Court for the Western District of Texas, and was argued by counsel;

ON CONSIDERATION WHEREOF, It is now here ordered and adjudged by this Court that the judgment of the said District Court in this cause be, and the same is hereby, affirmed in part and reversed in part; and that this cause be, and the same is hereby remanded to the said District Court for further proceedings not inconsistent with the opinion of this Court.

It is further ordered that plaintiffs-appellants-cross appellees pay to defendants-appellees-cross appellants the costs on appeal to be taxed by the Clerk of this Court.

April 14, 1970

Issued As Mandate:

## Opinion of the Court of Appeals

IN THE UNITED STATES COURT OF APPEALS
FOR THE FIFTH CIRCUIT

No. 27412

BECKMAN INSTRUMENTS, INC., and
LELAND C. CLARK, JR.,
*Plaintiff-Appellants-Cross-Appellees,*

v.

CHEMTRONICS, INC. and J. RYAN NEVILLE,
*Defendants-Appellees-Cross-Appellants.*

*Appeals from the United States District Court for the Western District of Texas.*

(April 14, 1970)

Before GEWIN, THORNBERRY and AINSWORTH, Circuit Judges.

THORNBERRY, Circuit Judge: This patent appeal concerns two inventions used in electrochemical analysis. Appellant Beckman sued appellee Chemtronics in the court below, requesting an injunction against continued infringement of its patent. Chemtronics replied by denying infringement, challenging the validity of Beckman's patent, raising issues as to ownership of the patent, charging patent misuse, accusing Beckman of fraud on the Patent Office, and counterclaiming for treble damages under both sections of the Sherman Act.[1] Confronted with this maze of issues, the district court held the patent valid but unin-

[1] The plaintiffs in the action below were Beckman, the holder of the patent, and Clark, Beckman's licensor. They are appellants in this appeal, contesting the trial court's judgment of noninfringement. The appellees, defendants below, are Chemtronics, the manufacturer of the allegedly infringing device, and Neville, the original patentee of that device. The appellees, Chemtronics and Neville, are also cross-appellants, having been denied relief on their antitrust counterclaim.

fringed. Consequently, it denied all relief requested by the parties.

Before considering the issues, we observe that the Supreme Court has indicated that this disposition of patent cases, even though it is usually the simplest way to deal with complex litigation, should be reviewed with care. In *Sinclair & Carroll Co., Inc.* v. *Interchemical Corp.*, 1945, 325 U.S. 327, 65 S.Ct. 1143, 89 L.Ed. 1644, the Court observed that "[t]here has been a tendency among the lower federal courts in infringement suits to dispose of them without going into the question of validity of the patent .... It has come to be recognized, however, that of the two questions, validity has the greater public importance."[2] The Court in *Sinclair* went on to reverse a circuit court's judgment of noninfringement and to hold the patent invalid. During the current term, the Court took similar action in *Anderson's-Black Rock, Inc.* v. *Pavement Salvage Co.*, 1969, 90 S.Ct. 305, reversing an order of the Fourth Circuit holding a patent valid in an infringement suit. In the course of its opinion, the Court reemphasized the public importance of the validity issue. The reason for the public interest in patent validity is clear: A patent confers a monopoly on its holder, and the law does not allow the granting of these valuable franchises to private individuals, with consequent public detriment, unless there is a concomitant public benefit.[3]

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[2] *See also Graham* v. *John Deere & Co.*, 1965, 383 U.S. 1, 86 S.Ct. 684, 15 L.Ed.2d 545; *Great Atlantic & Pacific Tea Co.* v. *Supermarket Equip. Co.*, 1950, 340 U.S. 147, 71 S.Ct. 127, 95 L.Ed. 1962; *Cuno Engineering Corp.* v. *Automatic Devices Corp.*, 314 U.S. 84, 62 S.Ct. 37, 86 L.Ed. 58 (all reversing holdings of validity in infringement suits); *cf. Hotchkiss* v. *Greenwood*, 1850, 52 U.S. (11 How.) 248, 13 L.Ed. 683.

[3] The cases emphasizing the importance of the public interest in patent validity emphasize that the requirement of a public benefit is a *constitutional* one:

> [2, 3] The patent standard is basically constitutional. Article I, § 8, of the Constitution authorizing Congress "To promote the Progress of * * * useful Arts" by allowing inventors

Against this background, we affirm the denial of relief against appellee, but on different grounds from those advanced by the district court. We disagree with the court's holding that the patent is valid. Because of this holding, we are not required to examine the court's finding of non-infringement.[1] We are, however, required under our view

monopolies for limited times. We stated in Graham v. John Deere Co., 383 U.S. 1, 6, 86 S.Ct. 684, 688, 15 L.Ed.2d 545, that under that power Congress may not "enlarge the patent monopoly without regard to the innovation, advancement or social benefit gained thereby. Moreover, Congress may not authorize the issuance of patents whose effects are to remove existent knowledge from the public domain, or to restrict free access to materials already available. Innovation, advancement, and things which add to the sum of useful knowledge are inherent requisites in a patent system which by constitutional command must 'promote the Progress of * * * useful Arts.' This is the *standard* expressed in the Constitution and it may not be ignored."

*Anderson's Black Rock* v. *Pavement Salvage Co.*, 1969, 90 S.Ct. 305, 308.

[1] *See Waldon, Inc.* v. *Alexander Mfg. Co.*, 5th Cir. 1970, — F.2d — [No. 27711, slip opinion dated Feb. 25, 1970]. *See also Heyer* v. *Duplicator Mfg. Co.*, 1925, 263 U.S. 100, 44 S.Ct. 31, 68 L.Ed. 189 (dictum; Holmes, J.); *Swafford* v. *B. & W., Inc.*, 5th Cir. 1968, 395 F.2d 362; *Zero Mfg. Co.* v. *Mississippi Milk Producers' Ass'n*, 5th Cir. 1966, 358 F.2d 583.

In a few cases appellate courts have avoided patent validity questions even though validity seemed doubtful by finding non-infringement and holding that this finding disposed of all issues. *See Autogiro Co. of America* v. *United States, Ct. Cl.* 1967, 384 F.2d 391; *Peters & Russell, Inc.* v. *Dorfman*, 7th Cir. 1954, 188 F.2d 711; *Universal Oil Prod. Co.* v. *Globe Oil & Ref'g Co.*, 7th Cir. 1943, 137 F.2d 3. This approach does not seem appropriate in this case. In the first place, the patent sued upon is broad and general, and we have doubts that the trial court's conclusionary finding of noninfringement would furnish an easy path for avoidance of validity. More importantly, however, the emphasis the Supreme Court has put upon the validity issue convinces us that the Court does not favor avoidance. Accordingly, we find that when a challenge is made to the validity of a patent in an infringement suit, that issue should ordinarily be taken up first and infringement considered only if validity is decided favorably to the patentee.

of the case to consider appellees' anti-trust counterclaim, and we find that we must remand this part of the case to the district court for further proceedings.

## I. Background: The Inventions at Suit

Both inventions at issue are designed primarily to determine the concentration of oxygen in liquids or gases. Fast and accurate determination of this concentration can be done by electrical analysis. The basic principles of the type of electroanalysis used here have been known for a long time, but the application of these principles to practical problems is often extraordinarily difficult. The electrodes of the measuring device must come into contact with the sample that is being analyzed, and the most serious problems occur at this contact point when either (1) the substance used to make the electrodes reacts with, and pollutes, the sample, or (2) the sample fouls the electrodes by plating them. It is the solution of this problem that characterizes the inventions at suit.

The devices at issue here are both improvements on a principle of electrochemistry known as *polarography*. Polarography was invented in 1923 by a Czech scientist named Heyrovsky, who used what is known as a "dropping mercury electrode" for his negative electrical contact, the one that came into contact with the substance to be measured. Above the electrode was a reservoir of mercury, leading down into a dropper which had contact with the sample; a drop of mercury would form in the sample, make electrical contact, react with and become fouled by the sample, and then drop harmlessly to the bottom of the tank, to be replaced by a new drop. Thus, although the electrode was continuously being fouled it was also continuously being renewed.

Heyrovsky created a voltage across the positive and negative electrodes of the device, varied the voltage, and observed the current that was produced by increasing voltages. At a certain voltage, depending on the composition

of the sample, the current would suddenly jump from one relatively constant level to another. This was so because at that certain voltage the substance diffused from solution to the negative or measuring electrode, was forced by that electrode to take on electrons, and caused a current to flow. The current produced was proportional to the rate of diffusion, which in turn was proportional to the concentration of the sample in solution; this is the basic principle behind polarography. Heyrovsky's invention was valuable because the voltage at which the reaction occurred could be used to identify the components of the sample and the amperage of the current generated could be used to determine the concentration of these components. Thus polarography, loosely defined, is a method of electrochemical analysis which involves the use of a voltage across a sample solution to generate a measurable current, which is then used to determine concentration of components in a sample.[5]

Since 1923, there have been numerous improvements upon and new applications of the polarographic principle. It has been possible in many cases to replace the clumsy and limited dropping mercury electrode with solid electrodes that are easier to use; this replacement has sometimes involved protecting the electrode by a membrane selectively permeable to the substance to be measured. The membrane prevents both fouling and pollution while allowing the appropriate sample constituent to diffuse through to the measuring electrode.

In 1954, Dr. Richard Stow advanced the art of membrane electrochemistry by an elegantly simple invention that is part of the background to this litigation. The invention as he actually constructed it was not within the

[5] We do not attempt to state an exact definition of this term, because its meaning is vigorously disputed in this suit. We have found it necessary, in fact, to disregard the word itself in several instances and to examine instead the function of the devices involved.

realm of polarography, but rather concerned a related field called *potentiometric* analysis. Stow placed *both* electrodes behind a single selectively permeable membrane, with one electrode surrounding the other concentrically, and was able to measure the concentration of carbon dioxide in blood, a measurement theretofore difficult to make. Stow did not patent his device, but disclosed it to the public by a published article and a public speech.

Beckman's licensor, Dr. Leland C. Clark, who is an appellant along with Beckman in this case, was also concerned with analysis of blood components. Specifically, he had been trying to find a way to measure blood oxygen content (in order to study respiratory diseases and the like), and had attempted to adapt polarographic techniques by covering one electrode with a membrane. Many others were attempting to make this same measurement; the problem had, in fact, confronted the scientific community for some time. One day the answer came to Clark all of a sudden: Instead of wrapping only one electrode in a membrane, he could put both electrodes behind the same membrane. This electrode arrangement, of course, was identical to the one Stow had invented. The cell Clark originally constructed had two concentric electrodes surrounded by a single selectively permeable membrane, and looked a great deal like the Stow device.[6] It was success-

[6] The Stow cell consists of a test-tube-like glass finger with a smaller glass finger inside it, covered at the end by a bag-shaped rubber membrane. Defendants' exhibit S-22, 7 Joint Appendix at 550. These glass structures contain the substances of which the two electrodes are made, and the glass at the tip of the finger is so thin as to allow passage of ions. The assembly is patterned after a well-known device called a glass electrode. The device described by the patent in suit and the device actually sold by Beckman are different in appearance from the Stow cell, but two reproductions of the cell that Clark *originally* built were introduced as exhibits in the suit, and these cells, like Stow's invention, consist of concentric fingers of glass with a membrane bag tied on the end. Plaintiffs' Exhibit 3.

ful in measuring oxygen in blood. Clark, who appears to have been somewhat more an entrepreneur than Stow, negotiated with Beckman, sold Beckman rights in his device, and assisted Beckman in getting a patent on it. It is this patent upon which Beckman's suit in the instant case is premised. Since being patented, the Clark device has been refined considerably. Today, Beckman manufactures an instrument with the Clark cell miniaturized in the head of a needle so that it can be immersed in a patient's blood vessels to determine blood oxygen content while the blood is circulating in the body. Beckman has seventeen sublicensees and sales have run into the millions of dollars.

The allegedly infringing device manufactured by appellee Chemtronics is described in a patent secured by Dr. J. Ryan Neville, who is also an appellee. The purpose of the device is to sense the amount of oxygen inside aviators' masks. Neville apparently invented it without reference to Clark's invention, although he was aware of Clark's earlier work and the work of Stow.

## II. The Validity of the Patent Sued Upon

We find the patent sued upon in this case to be invalid for two independent reasons. The first is that the patent is anticipated by prior art. As written, its claims include only the invention of Stow, with no novel additions. The second is that Beckman, in securing the patent, failed to fulfill the "uncompromising duty" of disclosure of an applicant before the Patent Office, because Beckman, while possessed of information regarding Stow's invention and realizing its significance, omitted that information from its patent application. The social and economic implications of a decision upholding a patent such as this would extend far beyond determination of the rights of the parties to this case, and we think such a decision would adversely affect the operation of the patent system Congress intended to create—a patent system that should re-

main compatible, in so far as possible, with the goal of limiting monopoly to situations of probable public benefit.[7]

At the outset, we should state what is not at issue here. Under the view we take of this case, we are not required to decide whether Dr. Clark created an invention that could have been protected under a proper, lawfully secured patent.[8] Thus the undeniable commercial success of the device, the fact that the blood oxygen problem had previously evaded solution, and the subsequent acclaim the device was accorded are largely irrelevant to our question. We assume for purposes of the following discussion that Clark's cell was patentable in some manner. This assumption granted, there are many ways that a patent on the device could have been written, and appellants in this instance chose to write it broadly and generally. Our attention must focus on the claims the patent actually makes. *Cf. Hensley Equip. Co.* v. *Esco Corp.*, 5th Cir. 1967, 383 F.2d 252.

A. *Anticipation of the Patent Claims by the Prior Art*

(1) The Legal Standards for Patent Validity as Respects Prior Art

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[7] *See Graham* v. *John Deere Co., supra; Transparent Wrap Mach. Co.* v. *Stokes & Smith Co.*, 1947, 329 U.S. 637, 67 S.Ct. 610, 91 L.Ed. 563; *Precision Instrument Mfg. Co.* v. *Automotive Maintenance Mach. Co.*, 1945, 324 U.S. 806, 65 S.Ct. 993, 89 L.Ed. 1381; P. Areeda, *Antitrust Analysis*, Ch. 5 (1967).

[8] Examination of *United States* v. *Adams, supra*, is relevant to this inquiry. It clearly indicates that the existence of the Stow device, with its particular elements working in combination to produce a synergistic result, would not negative invention in the case of the Clark *electrode* itself, since that electrode involves different interactions among different materials. The claims of Clark's patent are not, however, limited to any set of materials that produce any specific synergistic result except the result obtained by the arrangement that Stow developed. They cannot be read to be further limited. It is this fact, and not want of invention, that invalidates the patent. *See* note 17 *infra* and accompanying text.

A presumption of validity ordinarily attaches to patents that have survived the scrutiny of the Patent Office. 35 U.S.C. § 282 (1954); *Helms Prod.* v. *Lake Shore Mfg. Co.*, 7 Cir. 1955, 227 F.2d 677, 680; *Williams Mfg. Co.* v. *United Shoe Mach. Corp.*, 6th Cir. 1941, 121 F.2d 273, *aff'd* 316 U.S. 364, 62 S. Ct. 1179, 86 L. Ed. 1537. But the presumption of validity rests on the fact that patent approval is a species of "administrative determination supported by evidence." Consequently, when the defendants in an infringement suit attack the validity of a patent on the ground that it includes prior art that has not been presented to the patent office, the basis for the presumption vanishes, the presumption is significantly weakened, and the Court is required to scrutinize the patent more closely. *Zero Mfg. Co.* v. *Miss. Milk Ass'n*, 5th Cir. 1966, 358 F.2d 853; *Correll* v. *Adams Engineering Co.*, 5th Cir. 1958, 258 F.2d 874; *Rosaire* v. *Baroid Sales Division, Nat'l Lead Co.*, 5th Cir. 1955, 218 F.2d 72. In this case, appellants, for whatever reason, did not present the Stow device to the Patent Office, and hence we must compare that invention against the patent at suit without the usual strong presumption in favor of validity.

The three germinal tests of patent validity are utility, novelty, and nonobviousness. 35 U.S.C. §§ 101, 02, 103 (1954); *Graham* v. *John Deere Co.*, *supra*, 383 U.S. at 12-13, 86 S. Ct. at 691-92. Section 102, which pertains to novelty, requires that the patentee be the original inventor of the object claimed in his patent, and also that the invention not have been known or used by others before his discovery of it. Thus one obviously cannot be the original inventor if someone else has described or used the subject matter of the claims before the earliest moment to which he can trace his invention: *Corona Cord Tire Co.* v. *Dovovan Chem. Corp.*, 1928, 276 U.S. 358, 48 S. Ct. 380, 72 L.Ed. 610; *Alexander Milburn Co.* v. *Davis-Bournaville Co.*, 1926, 270 U.S. 390, 46 S. Ct. 324, 70 L. Ed. 651; *McCutchen* v. *Singer Co.*, *supra*. Fur-

thermore, the prior art is to be considered as covering all uses to which it could have been put. Thus a patent claiming a device that has already been put to use, albeit in a different manner, is invalid; in order to be valid over the prior art, it must claim not novel use, but novel conception. *Anderson's-Black Rock, Inc.* v. *Pavement Salvage Co., supra; Graham* v. *John Deere Co., supra*, 383 U.S. at 4-10, 86 S. Ct. at 687-90; *Rosaire* v. *Baroid Sales Division, Nat'l Lead Co., supra.*[9]

In examining the claims of the patent, we find that appellants have attempted to claim a particular arrangement of electrodes and membrane, for whatever materials may be used, throughout the entire field of polarographic analysis. Comparing that claimed arrangement with the arrangement invented by Stow, we find it to be identical to Stow's prior invention and simply put to a different use.

(2) Construction of the Patent Claims

In examining the patent claims, we must construe them narrowly so as to avoid the prior art if such a construction can reasonably be adopted. *Automatic Devices Corp.* v. *Sinko Tool & Mfg. Co.*, 7th Cir. 1940, 112 F.2d 335, *aff'd*, 1941, 314 U.S. 94, 62 S. Ct. 42, 86 L. Ed. 65; *Dominion Magnesium Ltd.* v. *United States*, Ct. Cl. 1963, 320 F.2d 388, 394. We shall do so here, even though we do not find the presumption of validity at its full strength. Appellants argue that the patent must be construed to

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[9] The Court in *Graham* v. *John Deere Co., supra*, 383 U.S. at 7-11, 86 S.Ct. at 688-90 & n. 3, quotes extensively the writings of Thomas Jefferson, whom it identifies as the "first administrator of our patent system." Jefferson summarized the significance of "new use" to patentability as follows: "A machine of which we are possessed, might be applied by every man to any use of which it is susceptible," i.e., a new use is not entitled to the patent monopoly. T. Jefferson, *Letter to Isaac McPherson*, in 6 Writings of Thomas Jefferson, 180-181.

apply to polarographic devices only. We do not find this argument to be highly persuasive since the patent title limits itself only to "electrochemical" devices generally and the language throughout is directed toward electrochemical analysis generally. The first paragraph of the specification, for example, is as follows:

> This invention relates to an electrolytic device for use in chemical analysis, and particularly to a polarographic cell adaptable for use in making quantitative analyses, especially continuous analyses.

If the patent was indeed intended to apply only to polarographic devices, the wording is curious, because it includes "electrolytic" analysis generally, and "polarographic" analysis only particularly.[10] Nevertheless, under the rules of patent construction, we are inclined to resolve our doubts in favor of appellants' argument. Accordingly, we assume, as appellants have urged that we should, that the patent covers only devices for polarographic analysis.

Having read the claims and found them limited to polarography, however, we do not think it reasonable to construe them any more narrowly than as establishing a monopoly on the claimed electrode arrangement throughout the entire field of polarography. The patent is not intended to set forth any specific combination of components, method of operation, or other refinement for use with this electrode arrangement. Looking first to the description, we find the following language:

> Accordingly, the primary object of this invention is to provide an electrode pair supported in prede-

[10] In addition, the specification states the "primary object" of the invention as encompassing the arrangement of electrodes and membrane, without limiting the use of that arrangement to polarography. Several of the claims do not contain the word polarography or any other language that would limit them to that field.

termined spaced relationship and electrically connected by an electrolyte or a substance reactable to form an electrolyte, and to provide a selectively permeable barrier for separating the electrode pair and the electrolyte or other substance from the composition to be analyzed."

It is to be noted that this description reads directly upon the Stow device.[11] The patent continues by stating, "A further object of this invention is to provide a cell for use in polarography . . . ." Thus even assuming that the description can be considered to be limited to the field of polarography, it at least covers every use of the claimed arrangement of electrodes, which is identical to that invented by Stow, within that broad field. It is certain that the patent description, which is broad and which uses the term "polarography" broadly,[12] cannot be used to limit the patent to anything more narrow than Stow's arrangement of electrodes, used in polarography.

The claims themselves, which are the primary object of our attention, are of no help in limiting the patent beyond this broad field either. Every one of them describes a device including a membrane permeable to the substance to be measured, with both electrodes behind the membrane and with the sample chamber on the other

[11] The Stow device is described generally at section I of this opinion, *supra*.

[12] The testimony of every witness except defendants' expert Bard interpreted the term to include virtually any technique of electrochemical analysis that functions by measurement of current generated through a sample. The patent itself clearly does not use a strict definition of the term, because it includes both devices with solid electrodes and self-energized devices, neither of which, according to defendants' expert Bard, comports with generally accepted strict usage. The usage of the term in the patent, even though not in keeping with strict, scientific nomenclature is, however, quite evidently in keeping with the common use of the term, as the testimony and exhibits amply demonstrate.

side, all supported by whatever structures are necessary and filled with whatever electrolyte is necessary. The claims do not describe any particular materials or processes; they claim the broad concept, including the use of *all* materials or processes that *might* be applicable to polarography.

(3) Anticipation by Stow

Dr. Richard Stow, as Beckman's patent liaison employee Strickler recognized, was the original inventor of the "broad concept of the dual electrode within a permeable membrane."[13] There is no question in this case that Stow constructed and publicly described a functioning device that embodied the same electrode-membrane arrangement that is sued upon here before appellants filed their patent application.[14] The only difference between

[13] Defendants' exhibit N-48, Letter from Allen Strickler to T. V. Parke, 7 Joint Appendix at 473-74.

[14] At trial, appellants attempted to show by testimony that the disclosure by Stow was insufficient to publish the art. The attempt does not appear persuasive, and on this appeal appellants have prudently abandoned the issue:

> The only description of the device published at a date prior to Clark's patent application is an "abstract" appearing in the American Journal of Physiology, Vol. 179, 1954, page 678, a single paragraph without drawings, Exhibit 8 [IV-45]. This description is possibly inadequate to teach a skilled artisan how to build the carbon dioxide measuring instrument, but whether it is or not there is evidence that Stow described it fully at a meeting of the American Physiological Society in Madison, Wisconsin in September 1954 [II-221]. A copy of his presentation is in evidence as Defendant's Exhibit O-2 (Stow Dep. II-221) . . . . In any event it appears that Stow had communicated a description of his instrument to the plaintiff Beckman Instruments at a time prior to Clark's invention [C. 108, p. 484-485] so the instrument itself is agreed to be properly considered as part of the "prior art," notwithstanding any inadequacies of description in the abstract, Exhibit 8.

Brief for Appellants at 31-32.

the device invented by Stow and the almost equally broad concept disclosed in the patent is the use of the latter in polarography.[15]

It is true, as appellants have pointed out, that Stow used his invention in connection with potentiometric analysis, which involves measure of voltage, rather than in polarography, which involves measurement of current. It is likewise true that there are important differences between these two analytical processes; but there are also important similarities, and it is the similarities that are relevant here. Both processes are methods of electrochemical anlysis. Both frequently involve the exact problem that the two polarographic devices here in suit were invented to solve—the problem, that is, that there must be electrical contacts with the sample, and those electrical contacts may become fouled by, or pollute, that sample.[16] Stow was the first to solve the problem by the use of a dual electrode covered by a single membrane, and this invention could be adapted, by the use of specific

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[15] Another, very minor difference has also been advanced by appellants. The liquid inside the membrane of the Stow device is distilled water, which is *not* an electrolyte, but it reacts during use with the carbon dioxide it is intended to measure to form carbonic acid, which *is* an electrolyte. Appellants point out that the liquid in the Clark cell begins as well as ends as an electrolyte. We are not persuaded that this difference matters, especially, when, upon inspecting the *patent* (rather than any particular Clark cell), we read the language, "Accordingly, the primary object of this invention is to provide an electrode pair . . . electrically connected by an electrolyte *or a substance reactable to form an electrolyte* . . . ." (emphasis added).

[16] In this connection, it is instructive to note that Stow was attempting to measure a component in exactly the same medium that Clark was studying—blood. He had to immerse his electrodes in the blood sample. Until he made his breakthrough by putting both electrodes, on the side of the membrane opposite from the sample, he found the measurement impossible because the sample fouled his electrodes. Clark's experience was exactly the same.

materials chosen to interact so as to produce the desired result, to the solution of an unlimited number of problems. The novel solution of any particular type of problem, through the use of a set of materials carefully chosen to interact properly, would be patentable even after Stow. *United States* v. *Adams*, 1965, 383 U.S. 39, 86 S. Ct. 708, 15 L. Ed. 2d 572.[17]

Instead of claiming such a proper subject of invention, appellants have attempted the wholesale importation of Stow's "broad concept" into the field of polarography, claiming a patent monopoly throughout that field. Polarography is itself a vast, important area of analytical chemistry, even though it is not a household word. Heyrovsky, its inventor, was awarded the Nobel Prize for inventing it.[18] The testimony shows that college students in chemistry

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[17] Appellants relied heavily upon the *Adams* case in the trial court, claiming that the patent sued upon here presents an "analogous" legal situation. The situations are clearly not analogous. The claims of the Adams patent that the court held valid read as follows:

> 1. A battery comprising a liquid container, a magnesium electropositive electrode inside the container and having an exterior terminal, a fused cuprous chloride electronegative electrode, and a terminal connected with said electronegative electrode.
>
> 10. In a battery, the combination of a magnesium electropositive electrode, and an electronegative electrode comprising cuprous chloride fused with a carbon catalytic agent.

The claims sued upon in this case are numbers 9 and 10 of the appellants' patent, which is reproduced as Appendix A hereto. These claims, in comparison to those held valid in *Adams*, are extremely general. The situation would be comparable, in light of the prior art, only if in *Adams* the Supreme Court had held valid a patent claiming any and all batteries capable of construction, no matter what their components or mode of operation.

[18] See 2 Joint Appendix at 315 (testimony of defendants' expert Bard).

are routinely taught the fundamentals of the subject.[19] Its uses are many and varied. Despite our willingness to assume that Clark created a patentable invention, we cannot hold that this patent, which merely puts the unchanged Stow electrode arrangement to a use covering the broad field of polarography, validly claims any invention at all.

To put it simply, the doctrine that "new uses" are not patentable means that Stow was the inventor of the "broad concept of the dual electrode within a permeable membrane" not only for use in potentiometric cells, but for use with electrochemical cells generally. Obviously, this proposition does not mean that Stow had carried the art to its highest attainable level. A subsequent inventor could claim to have improved upon the broad concept. But the important point is that no subsequent inventor could claim a patent monopoly on the use of Stow's "broad concept" in the entirety of an established, generalized field of analytical chemistry. We conclude, after having examined the claims at suit, that this is precisely what appellants have attempted to do.

B. *Beckman's Failure To Disclose the Stow Invention to the Patent Office*

As we have pointed out, one reason for our *de novo* inspection of the patent against the Stow device is that the Stow invention was never brought to the attention of the Patent Office. There is no indication that this omission was caused by oversight; rather, all the evidence tends to show that Beckman made the omission deliberately. Appellants have not attempted to controvert that evidence, in fact, but have advanced the argument that Beckman was not required to set up "straw men it knew it could knock down" (i.e., obviously irrelevant prior art) in its

[19] *Id.* at 312.

disclosures to the Patent Office.[20] Inasmuch as we have found that the Stow device is not only relevant but actually renders the patent invalid, we obviously cannot accept this categorization of it.

Appellants' conduct must be examined against the standard of conduct required of an applicant before the Patent Office. The Patent Office does not have full research facilities of its own, and it has never been intended by Congress that it should. In examining patents, the Office relies heavily upon the prior art references that are cited to it by applicants. It is therefore evident that our patent system could not function successfully if applicants were allowed to approach the Patent Office as an arm's length adversary. The Supreme Court has described the posture of a patent applicant as follows:

> Those who have applications pending with the Patent Office or who are parties to Patent Office proceedings have an *uncompromising duty* to report to it all facts concerning possible fraud or inequitableness underlying applications in issue . . . . Public interest demands that all facts relevant to such matters be submitted formally or informally to the Patent Office, which then can pass upon the sufficiency of the evidence. Only in this way can that agency act to safeguard the public in the first instance against fraudulent patent monopolies.

*Precision Instrument Mfg. Co.* v. *Automotive Maintenance Mach. Co.*, 1945, 324 U.S. 806, 818, 65 S. Ct. 993, 999, 89 L. Ed. 1381 (emphasis added). The Sixth Circuit, in a

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[20] Appellants cite this language from *United States* v. *Standard Electric Time Co.*, D. Mass. 1957, 155 F. Supp. 949. The case by its own reasoning is clearly not applicable, however, to a situation in which the applicant knew that prior art was significant and yet failed to present it.

case also involving prior art that an applicant had failed to disclose, explained the duty thus:

> The Patent Office, not having testing facilities of its own, must rely upon information furnished by applicants and their attorneys. Pfizer and Cyanamid, like all other applicants stood before the Patent Office in a confidential relationship and owed the obligation of frank and truthful statements.

*Charles Pfizer & Co.* v. *FTC*, 6th Cir. 1968, 401 F.2d 574, 579. And in *Corning Glass Works* v. *Anchor Hocking Glass Corp.*, D. Del. 1966, 253 F. Supp. 461, 470, the court stated that "[a]bsolute honesty and good faith disclosure is necessary" in the filing of a patent application.

The district court held that the appellants were not guilty of "fraud" in this case. We find either that the district court was applying the wrong legal standard by construing fraud to mean something less than the "uncompromising duty" of disclosure required by the cases or, alternatively, that the finding is clearly erroneous under the evidence as a whole. We are left with the "definite and firm conviction" that appellants' conduct did not measure up to the legal standard.

In the first place, it is clear that Beckman's patent employees understood the significance of Stow's invention and knew that it presented a serious threat to the validity of the patent they were trying to secure. Beckman had previously been in touch with Stow. It had even furnished him materials that he used in making his invention. When Beckman was preparing to get the Clark device patented, its patent liaison employee Strickler came across Stow's work and wrote a memorandum to Beck-

man's manager of engineering and to the manager of the division in which he worked, stating as follows:

> A related matter has now come up that creates a rather ticklish situation. As of early 1954, Dr. Richard W. Stow of Ohio State University Medical Center corresponded with our [Beckman's] Sales Department . . . concerning a glass electrode adaptation that he was developing for $pCO_2$ measurement . . . . The electrode is similar to the Clark design in that reference and measuring electrodes are both placed behind a single semi-permeable membrane. *The Stow device is clearly within the scope of claims now in the Clark application* . . . Clark and Stow have known about each others' work. . . .
>
> We do not at the present time know whether Clark or Stow is the prior inventor as concerns the broad claims of the Clark application.[21]

Upon learning of this possible preemption of its newly acquired rights, Beckman quickly contacted Stow and attempted to purchase his invention as a protective measure. Stow replied, however, that his invention had been dedicated to the public, and Beckman was left with rights only in a device that it had reason to believe was not patentable. Appellants have not been able to controvert the evidence showing these facts, which are strongly established by the introduction of Strickler's letter.

In the second place, appellants not only failed to present the Stow device to the Patent Office, but also made affirmative representations in the papers they filed to the effect that there had been no previous invention displaying

[21] Defendants' exhibit N-48. Letter from Allen Strickler to T. V. Parke, 7 Joint Appendix at 473-474 (emphasis added). Stickler was knowledgeable both in patent law and in the pertinent art to some extent.

the properties that the Clark device had in common with the Stow device.[22]

Appellants' only reply to these facts is that they did not consider Stow's work to be relevant prior art. This assertion, however, is rendered utterly incredible both by Beckman's conduct and by the obvious similarity of the Stow and Clark devices. Furthermore, the determination that the prior art did not render the patent invalid should have been left to the Patent Office rather than being decided privately by Beckman and Clark. Consequently, we conclude that there was no excuse for appellants' failure to disclose Stow's work to the Patent Office, and this conclusion prevents us from considering Beckman's conduct as fulfilling an "uncompromising duty" of good faith disclosure. We are constrained to hold the patent invalid on this ground, also.

## III. APPELLEES' ANTITRUST COUNTERCLAIM.

In addition to contesting the infringement suit against them, appellees have counterclaimed for treble damages under sections 1 and 2 of the Sherman Act. This antitrust counterclaim is based upon *Walker Process Equip. Co. v. Food Mach. & Chem. Co.*, 1965, 382 U.S. 172, 86 S. Ct. 347, 15 L. Ed. 2d 247, in which the Supreme Court held that "the enforcement of a patent procured by fraud on the Patent Office may be violative of § 2 of the Sherman

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[22] For example, in a paper filed with the Patent Office during the pendency of the application, appellants represented that "*The Clark instrument is the only one which can measure the partial pressure of a gas in a fluid regardless of the composition of the fluid.*" Defendants' exhibit A, 5 Joint Appendix at 184 (emphasis in original). The Stow invention also has this capability. There are a number of similarly misleading representations throughout the papers filed by appellants that are contained in defendants' exhibit A.

Act provided other elements necessary to a § 2 case are present. In such an event the treble damage provisions of § 4 of the Clayton Act would be available to an injured "party."[23] The Court emphasized that only "intentional fraud," consisting of knowing and willful misrepresentation of material facts,[24] was actionable, and that mere "technical fraud," or honest mistake in judgment, was not.[25]

Because of the trial court's disposition of the issues in this case, the antitrust counterclaim was never fully

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[23] As might be expected the *Walker* case has already been a prolific source of litigation. *See, e.g., Dresser Industries, Inc.* v. *Heraeus Engelhard Vacuum, Inc.*, 3rd Cir. 1968, 395 F.2d 457; *Donald F. Duncan, Inc.* v. *Royal Tops Mfg. Co., Inc.*, 7th Cir. 1967, 381 F.2d 879; *Green* v. *Aerosol Research Co.*, N.D. Ill. 1968, 286 F. Supp. 627; *Diamond Int'l Corp.* v. *Walterhoefer*, D. Md. 1968, 289 F. Supp. 550; *Holmes* v. *Struthers Scientific & Int'l Corp.*, W.D. Pa. 1967, 268 F. Supp. 122.

[24] The Court stated that the patentee must have *obtained* the patent through fraudulent means. Lower courts have interpreted this and other statements in the case to mean that misrepresentations must be material for the cause of action to exist. *E.g., Corning Glass Works* v. *Anchor Hocking Glass Corp.*, D. Del. 1966, 253 F. Supp. 461, 470.

[25] For example, technical fraud may involve presentation of a trademark that is invalid because generic, *see Donald F. Duncan, Inc.* v. *Royal Tops Mfg. Co., supra*, or non-material omission of prior art before the Patent Office because the patentee reasonably thinks it is not relevant, *see Corning Glass Works* v. *Anchor Hocking Glass Co., supra*, or procurement of a patent on an obvious innovation, *see Gillette Mach. & Tool Co.* v. *KVP-Sutherland Paper Co.*, N.D. Cal. 1968, 297 F. Supp. 542. These matters are to be sharply distinguished from intentional fraud, which involves affirmative dishonesty. *See American Cyanamid Co.* v. *FTC*, 5th Cir. 1966, 363 F. 2d 768-72 (holding that FTC finding that patentee "withheld" evidence from the Patent Office authorized FTC to apply antitrust remedies).

considered below.[26] Since we take a different view of the case, we are unable to dispose of the counterclaim on this appeal. We think the case raises issues of fact that should be resolved in further proceedings in the trial court. Evidence in the record indicates that Beckman is by far the largest firm in the Clark-cell market, with just under half the industry's total sales. All other sales in this market have been subject to its royalty. There is also evidence that appellee Chemtronics, whose sales were approximately $25,000 the year before this suit was brought, suffered a 40 percent decrease in annual revenues after suit. There was testimony describing at least one instance in which Beckman threatened suit against a potential Chemtronics customer and caused that customer to withdraw its orders. Finally, there is evidence tending

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[26] The trial court's finding 19 states that "in view of the finding that plaintiffs were not guilty of fraud on the Patent Office, it must follow that defendant's counterclaim must be dismissed . . . ." The court's finding 18 treats the issue of deliberateness and bad faith, in the context of fraud on the Patent Office, stating that "in order to establish fraud it would have been necessary for defendants to prove that plaintiffs deliberately and in bad faith withheld from the Patent Office knowledge of the prior Clark and Stow work. The record does not support any finding of bad faith on the part of the plaintiffs." This finding, if it is a finding of fact, may have been based upon the court's finding that the Stow device and the prior Clark work did not anticipate the patent. Indeed, this basis seems the most probable one because there is certainly evidence that could support an inference of bad faith under our holding that Stow did anticipate the patent.

Thus the trial court simply was not faced with the issues upon which the counterclaim is based. Another reason for our conclusion that further proceedings are warranted is that the district court, under the view it took of the case, excluded evidence relevant to the counterclaim on appellants' objection that it was immaterial. 3 Joint Appendix at 357-59 (testimony of Beckman's employee Steinmeyer); Defendants' exhibit A, 7 Joint Appendix at 562-63. Without testimony, we are unable to interpret this exhibit. The exhibit relates to the extent of the market in which Beckman thought it could enforce its patent claims.

to show that appellants knew when they applied for their patent that they had omitted relevant, material prior art from their references. The trial court should look first to the evidence to determine whether appellants indulged in knowing, willful misrepresentation of material facts.[27] If it finds that they did, it should then look to see whether the other elements of Sherman Act violations are present —whether, for example, as regards monopolization, appellants have market power in some relevant market, whether they have used this power unlawfully, and whether they have directly caused appellees to suffer damage.[28]

In accordance with the above, we hold that the patent sued upon is invalid and affirm the denial of relief against appellees. That part of the judgment relating to the antitrust counterclaim, however, is vacated, and the cause is remanded for further proceedings on this issue not inconsistent with this opinion.

AFFIRMED IN PART AND REVERSED IN PART.

In view of the result of this appeal, costs shall be taxed against appellants.

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[27] Our holding above, that appellants did not fulfill an "uncompromising duty" of frank disclosure, is all that is required for us to dispose of the issues properly before us. It does not fully answer the question whether appellants engaged in willful and knowing misrepresentations of material facts.

[28] We do not fully understand the basis of appellees' other claim, that under section 1, but leave appellees to develop it, if they can do so, before the trial court. Provided the proper elements are present, we see no reason why the *Walker* cause of action should not encompass section 1 suits as well as monopolizations. *Cf. Lear, Inc.* v. *Adkins*, 1969, 89 S. Ct. 1902, 1910-11; *United States* v. *Singer Mfg. Co.*, 1963, 374 U.S. 174, 83 S. Ct. 1773, 10 L.Ed. 2d 823.

APPENDIX "A"

Nov. 17, 1959 L. C. CLARK, JR 2,913,386

ELECTROCHEMICAL DEVICE FOR CHEMICAL ANALYSIS

Filed March 21, 1956

FIG-1

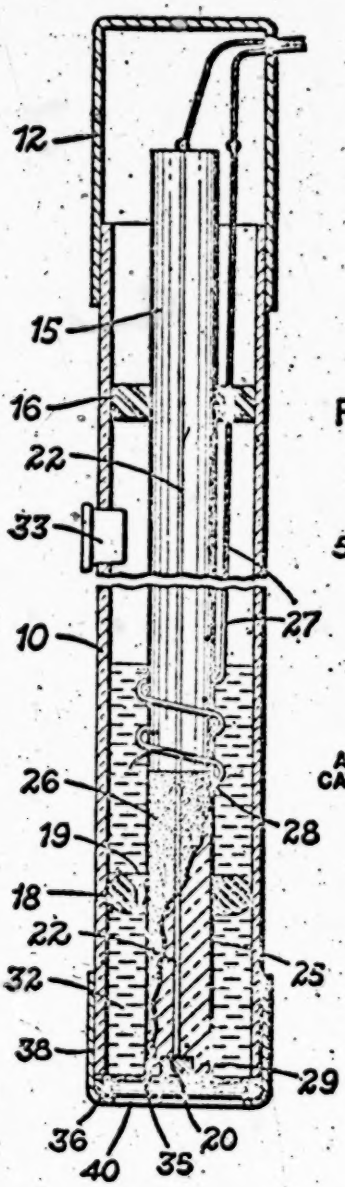



FIG-2

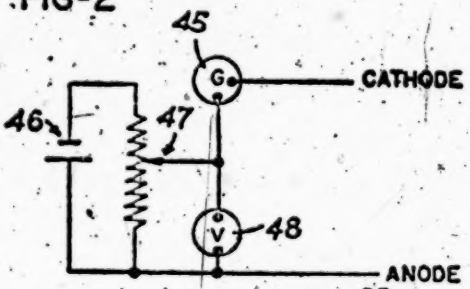



FIG-4

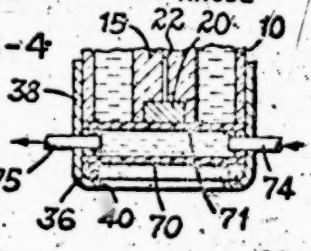
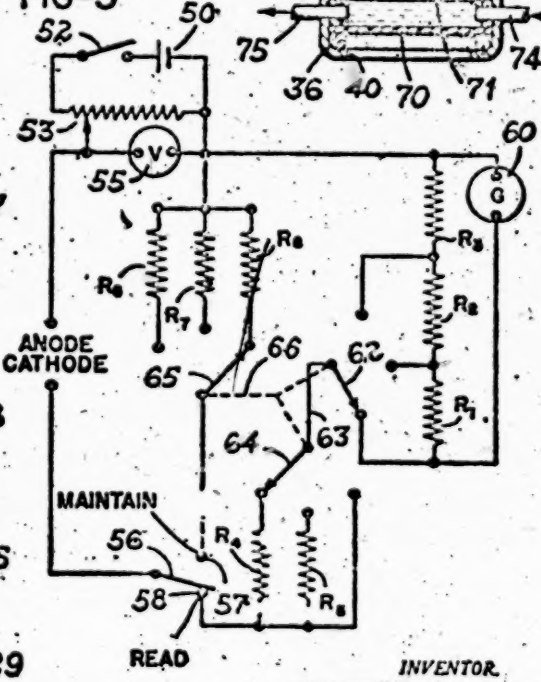



FIG-3




INVENTOR.
LELAND C. CLARK, JR.

BY

Fischal, Bubel, French & Bugg

ATTORNEYS

UNITED STATES PATENT OFFICE

2,913,386

Patented Nov. 17, 1959

# ELECTROCHEMICAL DEVICE FOR CHEMICAL ANALYSIS

Leland C. Clark, Jr., Yellow Springs, Ohio

Application March 21, 1956, Serial No. 573,029

14 Claims. (Cl. 204—195)

This invention relates to an electrolytic device for use in chemical analysis, and particularly to a polarographic cell adaptable for use in making quantitative analyses, especially continuous analyses.

The present invention provides a means whereby direct measurements of the proportional quantity of a substance in a composition of matter are made by noting the effect of that substance upon the electrical characteristics of a polarographic cell and comparing that effect with known or determinable standards. In its simplest form the polarographic cell comprises an anode and a cathode in electrical circuit with each other through a suitable electrolyte or electrolyte forming substance. The electrolyte is provided by a compound, solution, or other suitable material which will form with the anode and cathode an electric cell, and which will provide ions for reactions with the substance which it is desired to measure in such a way as to affect the electrical characteristics of the cell.

The application of polarography to many fields of science has been heretofore limited by the difficulties encountered in undesired reactions between the cell components which destroy the usefulness or accuracy of the cell, for example, by altering the properties of the electrolyte so that the reaction between the ions and a certain substance in a composition under analysis is interfered with or not accurately observable. Also, in some cases the cathode may become plated with certain substances in the composition, thereby

rendering the cell inoperable. As an example of such limitations in use of certain polarographic cells, the measurement of free oxygen in certain gases has been accomplished by bubbling the gas through liquid electrolyte in which an anode and cathode are immersed. Such a method however is not feasible with certain gases and with oils which are non-miscible with the electrolyte used. Furthermore, it is necessary to standardize the cell under such circumstances and it is quite likely that in the process of standardizing the properties of the electrolyte may be changed. Also, when the composition being continually analyzed is used as the electrolyte the properties of the electrolyte may change of their own accord, as in industrial fermentation processes for example. Substances which might plate the cathode and render the cell useless could be removed prior to analysis, yes, prior removal of the undesired substance from the composition to be analyzed could change the entire quantitative (or even qualitative) make-up of the composition and thus the subsequent determinations would be erroneous as to the original composition.

In accordance with this invention the anode and cathode pair are electrically connected through a "captive" electrolyte or electrolyte forming substance which is protected from turbulence and preferably is physically isolated and electrically insulated from the composition to be analyzed by a barrier means permeable to the substance which it is desired to measure in the composition, and which barrier means is impermeable to all other constituents of the composition which might have an effect on the electrical characteristics of the call.

Accordingly, the primary object to this invention is to provide an electrode pair supported in predetermined spaced relationship and electrically connected by an electrolyte or a substance reactable to form an electrolyte, and to provide a selectively permeable barrier for separating the electrode pair and the electrolyte or other substance from the composition to be analyzed.

A further object of this invention is to provide a cell for use in polarography embodying a pair of electrodes supported in predetermined spaced relationship and having a chamber around the electrodes containing an electrolyte in sufficient quantity to provide an electrical connection between them, and to provide a selectively permeable barrier means in a wall of the chamber for admitting only desired substances into the chamber for reaction with the electrolyte.

Another object of the invention is to provide such a cell including means for adding a buffer solution to the electrolyte in accordance with the need of such buffer to maintain the concentration of certain ions in the electrolyte as desired.

It is an additional object of this invention to provide analytical apparatus including a polarographic cell having an anode and a cathode immersed in an electrolyte and also having a membrane selectively permeable to the substance to be measured for isolating the cell members from the composition to be analyzed, and including suitable electrical controls and instruments for observing the quantity of electrical current passing through the cell.

Other objects and advantages of the invention will be apparent from the following description, the accompanying drawing and the appended claims.

In the drawing—

Fig. 1 is a detail view, partly in section and partly in elevation, of a cell according to the present invention;

Fig. 2 is a schematic diagram of a simple circuit in which the cell of Fig. 1 may be used;

Fig. 3 is a diagram of a circuit including the cell of Fig. 1 and a type of galvanometer for use in observing the changes in conductivity of the cell over a wide range of values; and

Fig. 4 is a detail view of a modified cell.

Referring to the drawing, which illustrates a preferred embodiment of the present invention, and particularly to Fig. 1, a typical cell in accordance with the present invention is illustrated as including a tubular body 10 defining a chamber closed at its upper end by a cap 12 and having an insulating rod 15 supported coaxially therewithin by means of an upper washer-like spacer 16, and a lower ring type of spacer 18 slotted at 19 to provide passage for liquid to the lower end of the cell. Within the lower end of rod 15 there is a button-type cathode 20 of a suitable conductive material connected to a cathode lead-in wire 22 which extends within rod 15 to the upper end thereof. The lower outer surface 25 of rod 15 is coated with a suitable conductive material 26 to provide an anode, and an anode lead wire 27 extends through the upper spacer 16 and is wrapped around the lower or coated surface 25 of rod 15 and suitably fixed thereto at a connection 28.

The spacing between the anode and cathode, provided by the thickness of the annular portion 29 of the lower end of rod 15, is thus maintained in predetermined fixed relation, and the space directly below this annular end portion 29 acts as a "bridge" through which ions are transferred and electrical current travels while the reactions occur in the space directly below cathode 20. An electrolyte material 32, preferably including a suitable buffer, is supplied to the well surrounding the lower end of rod 15 and thus to the aforementioned "bridge" and reaction spaces. This well maintains an adequate supply of electrolyte and assures an adequate supply of ions at the appropriate electrode, as necessary for operation of the polarographic cell. If additional solution is required after an extended period of operation, such solution may be added as desired through an opening in the side wall of tube 10, normally closed by a stopper 33.

The electrolyte, the electrodes, and the "bridge" and reaction spaces are all isolated and electrically insulated from the outside of the tube by a selectively permeable barrier

means provided by a membrane 35 extending across the end of tube 10 and held in place by an O-ring seal 36 received within the lower cap 38, which in turn is provided with a relatively large central opening 40 to admit the composition to be analyzed to the outer surface of membrane 35. The required spacing between membrane 35 and cathode 20 and the surrounding rod lower end 29 can be provided by roughening the annular lower face of the rod end 29 to provide for access of the electrolyte to the cathode.

The material of which membrane 35 is formed varies in accordance with the properties of the gas, solution, or other composition which it is desired to analyze. For example, when the cell is to be used for determining the oxygen content of a gas or a solution, membrane 35 may be of polyethylene which will pass the oxygen to the interior of the cell, while forming a barrier to other substances which would affect the electrical characteristics of the call.

In the operation of the cell the electrolyte 32 provides for the flow of electrons in the electro-reduction and electro-oxidation processes used in polarography. In the determination of oxygen content, for example, these processes take place in accordance with the overall equation

$$2H^{+} + O + 2e \longrightarrow H_2O$$

wherein $H^{+}$ represents a hydrogen ion, O represents an oxygen atom, and $e$ represents an electron. Of course, for continual determination a suitable supply of ions must be provided, for continual combination or reaction with the substance being measured. In determinations of oxygen, as an example, regulation of the hydrogen ion concentration to maintain an adequate supply of such ions at the cathode may be accomplished by adding a suitable buffer to the electrolyte.

The sensitivity of the cell may also be affected to some degree by liberation of ions from the noble metal cathode at low potentials and with electrolytes of certain pH values. This sensitivity can be overcome to a great extent by se-

lecting cathodes having desirably high values of overvoltage for the ions in question. For example, it has been found that in a cell for use in determinations of oxygen a gold cathode extends the usefulness of the cell over a wider range of pH values, since the gold has a high value of hydrogen overvoltage.

The electrical characteristics of the cell will be affected in proportion to the quantity of the substance to be measured passing through membrane 35. For instance, when measuring oxygen the electrical current carrying capacity of the cell will vary in direct proportion to the quantity of oxygen passing into the electrolyte, since a sufficient supply of hydrogen ions will be maintained by the buffer in the electrolyte tending to polarize the cell, and the cell will be depolarized in proportion to oxygen reacting with the hydrogen ions.

When such a cell is connected to a circuit as in Fig. 2, so that an applied voltage of about 0.6 volt is maintained across the cell, a current will flow in the presence of the substance being measured since that substance will tend to depolarize the cell. For example, current readings on the galvanometer 45 will be proportional to oxygen passing through the protective membrane. Such a cell, having a silver-silver chloride anode and a platinum cathode in an electrolyte of an aqueous sodium chloride solution, and suitably calibrated in gases having known oxygen tensions, will give a current flow which is proportional to the quantity of oxygen contained in the composition being examined.

A simple circuit such as in Fig. 2 includes a battery 46 having a potentiometer 47 connected to the terminals thereof, and a voltmeter 48 connected between the variable arm of the potentiometer and the positive terminal of the battery. The potentiometer and voltmeter provide for an accurate adjustment of the potential difference desired across the cell, usually in the vicinity of 0.6 v. The cathode is connected to the potentiometer contact on the negative

side of battery 46 and the anode is connected to the positive terminal, with the galvanometer 45 in line to the cathode. Variations in the current through the cell, as observed on galvanometer 45, will be in proportion to the quantity of the substance being measured passing through the selectively permeable barrier membrane 35 and reacting with ions in the cell to alter its electrical characteristics.

Fig. 3 illustrates another circuit in which the cell of Fig. 1 may be used, for observing relatively small electrical currents passing through the galvanometer. In this circuit a battery 50 is connected through switch 52 with a potentiometer 53. A voltmeter 55 is connected between the variable arm of potentiometer 53 and the negative terminal of battery 50, for the purpose of observing the potential difference between the arm of the potentiometer and the negative battery terminal, and thus to provide adjustment of the desired voltage to be impressed across the cell. The anode is connected to the potentiometer arm, and the cathode is connected to the central terminal of a single pole double throw switch 56 movable between an upper "maintain" position at contact 57, and a lower "read" position at contact 58.

The galvanometer 60 is provided with a plurality of shunting resistors R1, R2 and R3 in series with each other and connected in parallel across the terminals of the galvanometer. The selecting switch 62 has three positions wherein it connects a lead 63 to one or more of the resistors R1, R2 or R3, and the lead 63 is in turn connected to another switch 64 which is movable between positions connecting resistances R4 and R5 into the galvanometer circuit, or to a straight-through connection with the "read" contact 58. Switches 64 and 62 are operated simultaneously to select different series and paralleled combinations of resistances in circuit with the galvanometer. For example, in the position shown R4 is in series with the entire group of R1, R2 and R3, which are in shunt with the galvanometer.

The "maintain" contact 57 is connected to a third switch 65 connected at 66 to operate with switches 62 and 64, and movable between three positions wherein the cell is placed in series with one of resistances R6, R7, or R8. The value of these resistances is selected so as to correspond to the total resistance of the galvanometer and its various shunt and series circuits in the three positions of switches 62 and 64 and hence to balance the current and to maintain the same resistance regardless of whether the switch 56 is in the "read" or the "maintain" position. In practice, the various resistances have been selected to give a range of galvanometer readings sensitive to variations of one microampere, two microamperes and four microamperes with a battery of one-half volt and with a potential difference across the cell of about 0.6 v.

It is also possible under certain circumstances to select electrode pairs having a battery action, thereby providing a polarographic cell according to the invention which is self-energized. With such a cell the circuit shown in Fig. 2 may be further simplified, to the extent that the battery and potentiometer for impressing a predetermined potential difference across the cell are eliminated and the cell lead wires connected directly to a galvanometer or other suitable device for observing and/or recording the changes in current carrying capacity of such a self-energized cell. A cell of this type is especially suited for use in situations where it is desired to have a continuous analysis of a composition, but where a minimum of equipment requiring minimum attention is also desirable.

It may also be desirable in some instances to utilize a non-electrolytic type of captive "electrolyte" substance in the cell which will not conduct unless combined with or subjected to certain substances, radicals, ions, and the like under study. Accordingly, the term "electrolyte forming substance" as used herein is intended to embrace those substances which are in themselves electrolytes and also other substances which are capable of reacting with other

substances or radicals or ions under study to form an electrolyte. For example, in studying the concentration of certain ions in a solution, a normally non-conductive solution or paste may be provided between the electrodes of the cell of such character that it will be reactable with such ions to form a conducting solution or paste. Such a cell would then be standardized with known quantities of ions under study, and used to test such ions with the permeable barrier means selected to be permeable to such ions and impermeable to others which might react with the electrolyte forming substance to form an electrically conductive product.

It will be appreciated that different types of apparatus may be used to observe the electrical activity of the cell. For example, a recording galvanometer has been used in a circuit similar to the one shown in Fig. 3 to provide a continuous record of the changes in current flowing through the polarographic cell, and thus to give a continuous record of the quantity of the substance being measured. Successful results have been obtained with a cell utilizing a platinum cathode and a silver-silver chloride anode, and using an aqueous sodium chloride solution as an electrolyte. This cell is utilized for the determination of oxygen, and accordingly membrane 35 is formed from polyethylene. Suitable results have also been obtained in oxygen determinations using as an electrolyte an aqueous solution of sodium chloride with added glycerine. Other materials which have been found suitable for membrane 35 in oxygen determinations are silastic, rubber, and vinyl chloride.

It is also possible to provide a barrier means permeable only to the desired substances by passing a thin film of selectively permeable fluid between two thin fixed permeable plates or membranes. Such a modified construction is shown in Fig. 4, wherein suitable membrane plates 70 and 71 are supported in spaced relation, and a quantity of selectively permeable fluid, such as silicone oil, is passed be-

tween these plates from an inlet 74 to an outlet 75. Such a modified barrier means functions in the same manner and for the same purpose as the membrane 35 shown in Fig. 1.

The polarographic cell provided by this invention is adaptable to many uses and to a variety of scientific and industrial fields. For example, the cell can be used to determine oxygen in a liquid, a gas, or a solid. A cell can be devised for use in determining such electro-reducible or electro-oxidizable gases as $SO_2$, or to determine inert gases such as CO. In the latter instance, it may be desirable to have the inert gas react with special cell electrolytes whose electrical activity is affected in an irreversible way by the inert gas, and in such a case a large reservoir of the electrolyte solution can be maintained for diffusion slowing in front of the electrode surfaces. In determining solids, or salts in solution, the permeable barrier means is selected so as to be permeable to certain ions. For example, certain membranes made from ion exchange resins may be used, having surfaces or molecular charges such that they are permeable to certain classes of ions.

Polarographic cells sensitive to oxygen may be constructed in accordance with this invention in small sizes such that the diameter of cap 38 is about one-half inch and the length of the cell is in the order of four to five inches. Such a small cell can be calibrated in known atmospheres and subsequently utilized as an altimeter, or used in a face mask for an aircraft pilot to provide a hypoxia warning device. Other exemplary uses of the oxygen measuring cells are in determining the basal metabolism of a patient by measuring the oxygen consumption by difference between inspired and expired air and the volume of air exchanged, and in many industrial applications wherein it is desired to know the oxygen content of water, saline, sewage, oil, or other compositions.

While the forms of apparatus herein described constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to these precise forms.

of apparatus, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. A polarographic cell for use in analyzing a composition to determine the quantity of a certain substance in said composition, said cell comprising: an anode and a cathode; means supporting said anode and said cathode in fixed spaced relationship; means for confining an electrolyte forming substance in electrical current carrying contact with said anode and said cathode; means for impressing a predetermined electrical potential across said anode and said cathode; barrier means surrounding said anode and said cathode and said electrolyte forming substance to physically separate and electrically insulate said electrolyte from said composition being analyzed, said barrier means being permeable to the substance in said composition the quantity of which it is desired to determine, said substance being reactable with said electrolyte forming substance to alter the electrical characteristics of said cell, said barrier means being impermeable to all other constituents of said composition reactable with said electrolyte forming substance; and means for observing variations in the electrical characteristics of the cell caused by reactions between said electrolyte forming substance and said substance to which said barrier means is permeable.

2. In a device for use in determining the proportional quantity of a substance in a composition of matter, the combination of: a pair of electrodes; insulating means supporting said electrodes in predetermined spaced relationship; means defining a chamber around said electrodes; an electrolyte contained in said chamber in sufficient quantity to fill the space between said electrodes; a membrane selectively permeable to the substance to be measured, said membrane forming one of the walls of said chamber and being adapted to be exposed to the composition of matter,

said membrane separating said electrolyte from said composition and permitting passage of said substance therethrough into said electrolyte within said chamber; means for impressing a predetermined electrical potential across said electrodes; and means for measuring the current in the circuit comprising said electrodes and electrolyte.

3. In an electrode assembly for exposure to a constituent to be measured by polarographic analysis; the combination of: a first electrode providing a first surface thereon; a membrane selectively permeable to said constituent; means supporting said membrane with one face thereof closely adjacent to said first surface to define a liquid film space therebetween, the other face of said membrane being exposable to an environment containing said constituent to be measured; a reservoir for an electrolyte; liquid passage means between said reservoir and said film space for maintaining a film of electrolyte in said space; and a second electrode positioned on the same side of said membrane as said first electrode for contact with said electrolyte for forming an electrical circuit between said first electrode, said electrolyte, and said second electrode.

4. In an electrode assembly for exposure to a constituent to be measured by polarographic analysis, the combination of: a first electrode providing a first surface thereon; a membrane selectively permeable to said constituent; means supporting said membrane with one face thereof closely adjacent to said first surface to define a liquid film space therebetween, the other face of said membrane being exposable to an environment containing said constituent to be measured; a reservoir for an electrolyte forming substance, the volume of the reservoir being large relative to the volume of said film space; a restricted passage between said reservoir and said film space for maintaining a film of electrolyte forming substance in said space; and a second electrode positioned on the same side of said membrane as said first electrode for contact with said electrolyte forming substance for forming an electrical circuit between said

first electrode, said electrolyte forming substance and said second electrode.

5. In an electrode assembly for exposure to a constituent to be measured, the combination of: an electrically insulating support body; a first electrode embedded in said support body and having an exposed surface at a face of said body and substantially flush therewith; membrane means selectively permeable to said constituent; means for supporting said membrane with one face thereof closely adjacent to said electrode surface and said body face defining a liquid film space between said membrane and said electrode surface and defining an ionic passage between said membrane and said body face, the other face of said membrane being exposable to an environment containing said constituent; reservoir means for enclosing a body of electrolyte forming substance of relatively large volume compared with the volume of said film space, said reservoir means adjoining and communicating with said passage to maintain a film of said electrolyte forming substance in said film space; and a second electrode positioned on the same side of said membrane as said first electrode for contact with said electrolyte forming substance for forming an electrical circuit between said first electrode, said electrolyte forming substance and said second electrode.

6. In a probe assembly for polarographic measurement of oxygen in a gaseous or liquid medium, the combination of: an anode; a cathode; a chamber enclosing said anode and said cathode and adapted to contain an electrolyte for bridging said anode and said cathode, said chamber including an oxygen permeable barrier forming a wall thereof; means for maintaining said barrier closely adjacent to said cathode to form an electrolyte film space therebetween, said chamber isolating said medium from access to said film space and said cathode except by way of said barrier; circuit means for applying a potential to said cathode and said anode; and means coupled to said circuit means for

indicating a current in said circuit means as a function of oxygen permeating said membrane into said film space.

7. In a measuring cell for determining the presence of a particular substance in a composition of matter, the combination of: a chamber having an opening therein for communication with the composition of matter; an anode electrode and a cathode electrode; means for mounting said electrodes in said chamber in spaced relationship; selectively permeable and electrolyte forming means for blocking said opening and isolating said electrodes from the composition and forming an electric current path between said electrodes; and means coupled to said electrodes for impressing a predetermined electrical potential across said electrodes and observing variations in the electrical current characteristics of the cell as a function of the quantity of the particular substance permeating into said chamber.

8. In a measuring cell, the combination of: an anode electrode and a cathode electrode; means for supporting said electrodes in said cell in predetermined space relationship; a medium electrolytically bridging said electrodes to form an electrical circuit therewith; a chamber having two permeable walls permitting passage of selected substances into said chamber through one of said walls and out of said chamber through the other of said walls, the outer face of said one wall being positioned to be exposed to a composition being analyzed; means for mounting said chamber in said cell with both of said electrodes on the same side of said chamber and with the outer face of said other wall in contact with said medium; and means for passing a selectively permeable fluid through said chamber between said walls.

9. In a measuring instrument for exposure to a constituent to be measured, the combination of: a first electrode having a polarographic sensitive electrode surface; means for defining an electrolyte space adjoining said sensitive surface, said means including a membrane permeable to the

constituent to be measured, the outer surface of said membrane being exposable to an environment containing the constituent; a second electrode polarographically complementary to said first electrode, both said electrodes being positioned on the side of said membrane opposite the side exposed to said enviroment; and elecrolyte means providing an ionic solution in said electrolyte space in contact with said sensitive surface and the inner surface of said membrane, and forming an ionic bridge between said first and second electrodes, the volume of said electrolyte space being small to provide a short equilibration time for said electrolyte means and a short time constant in the measurement.

10. In an instrument for measuring a constituent in either a gaseous or liquid environment; the combination of: a polarographic sensing electrode; means defining an electrolyte space immediately adjacent to said sensing electrode, said means including a membrane permeable to said constituent, said membrane separating said electrolyte space from said environment; a body of electrolyte with at least a portion of said electrolyte filling said electrolyte space; and a reference electrode electrically isolated from said sensing electrode except through said electrolyte and positioned on the same side of said membrane as said sensing electrode for contact with said body of electrolyte, said sensing electrode effecting a signal current through said electrolyte and said reference electrode by removal of said constituent from said electrolyte space, said space being of small volume and providing a short diffusion path between said membrane and said sensing electrode for rapid equilibration of said current to changes of said constituent in said environment.

11. In a measuring instrument for use in determining the proportional quantity of a nonionic dissolved gaseous component in a composition to be analyzed, the combination of: an anode electrode and a cathode electrode; means for supporting said electrodes in predetermined relationship;

chamber means defining a chamber enclosing said electrodes, said chamber means including permeable membrane means for separating said electrodes from the composition to be analyzed, said membrane means being permeable to said gaseous component and impermeable to interfering ionic and nonvolatile components in the composition; an ionic solution enclosed in said chamber for forming an ionic path between said electrodes; and means for impressing a predetermined electrical potential across said electrodes to cause an ionic current flow in said path in response to transmission of said gaseous component from the composition through said membrane means into said chamber.

12. In a measuring instrument for exposure to a constituent to be measured, the combination of: a first electrode having a sensitive electrode surface; a second electrode electrically isolated from said first electrode; a membrane selectively permeable to said constituent; means for supporting said membrane for separating said electrodes from said constituent with one face of said membrane closely adjacent to said electrode surface to define a liquid film space therebetween, the other face of said membrane being exposable to an environment containing said constituent to be measured; and a body of electrolyte with at least a portion thereof positioned in said liquid film space in contact with said sensitive electrode surface and said membrane; for forming a current path from said second electrode through said electrolyte to said first electrode.

13. In a polarographic measuring cell the combination of: an anode electrode and a cathode electrode; means for supporting said electrodes in said cell in predetermined spaced relationship; a medium electrolytically bridging said electrodes to form an electrical circuit therewith; and selectively permeable barrier means carried by said cell for separating said electrodes and medium from a composition being analyzed, said barrier means permitting particular substances present in said composition to pass therethrough

and into said medium for producing changes in electrical characteristics of said circuit.

14. In a polarographic cell, the combination of: an anode electrode and a cathode electrode; means for supporting said electrodes in said cell in predetermind spaced relationship; and selectively permeable barrier means carried by said cell and positioned with respect to said electrodes to define a space adapted for filling with a medium to form an electrical circuit between said electrodes, said barrier means separating both said electrodes from a composition being analyzed whereby during cell operation particular substances present in said composition will pass therethrough and into the medium for producing changes in electrical characteristics of said circuit.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UNITED STATES PATENT OFFICE

# CERTIFICATE OF CORRECTION

Patent No. 2,913,386 November 17, 1959

Leland C. Clark, Jr.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Page 49, line 21, after "membrane" strike out the semicolon.

Signed and sealed this 3rd day of May 1960.

(SEAL)

Attest:

KARL H. AXLINE
*Attesting Officer*

ROBERT C. WATSON
*Commissioner of Patents*

## Order Denying Petition for Rehearing En Banc

IN THE UNITED STATES COURT OF APPEALS
FOR THE FIFTH CIRCUIT

No. 27412

BECKMAN INSTRUMENTS, INC., and LELAND C. CLARK, JR.,
*Plaintiffs-Appellants-Cross Appellees,*

versus

CHEMTRONICS, INC., and J. RYAN NEVILLE,
*Defendants-Appellees-Cross Appellants.*

*Appeals from the United States District Court for the Western District of Texas*

On Petition for Rehearing and Petition for Rehearing En Banc

(June 19, 1970)

Before GEWIN, THORNBERRY and AINSWORTH,
*Circuit Judges.*

PER CURIAM: The Petition for Rehearing is DENIED and no member of this panel nor Judge in regular active service on the Court having requested that the Court be polled on rehearing en banc, (Rule 35 Federal Rules of Appellate Procedure; Local Fifth Circuit Rule 12) the Petition for Rehearing En Banc is DENIED.

## APPENDIX B

### Constitutional and Statutory Provisions

1. Article I, Section 8, Clause 8, of the Constitution provides:

> The Congress shall have Power . . .
>
> * * *
>
> To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries. . . .

2. Sections 101, 102 and 103 of the Patent Code of 1952 provide (35 U.S.C. §§ 101-03):

> § 101. Inventions patentable
>
> Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.
>
> § 102. Conditions for patentability; novelty and loss of right to patent
>
> A person shall be entitled to a patent unless—
>
> (a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for patent, or
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of the application for patent in the United States, or
>
> (c) he has abandoned the invention, or
>
> (d) the invention was first patented or caused to be patented by the applicant or his legal representatives or assigns in a foreign country prior to the date of the application for patent in this country on an application

filed more than twelve months before the filing of the application in the United States, or

(e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or

(f) he did not himself invent the subject matter sought to be patented, or

(g) before the applicant's invention thereof the invention was made in this country by another who had not abandoned, suppressed, or concealed it. In determining priority of invention there shall be considered not only the respective dates of conception and reduction to practice of the invention, but also the reasonable diligence of one who was first to conceive and last to reduce to practice, from a time prior to conception by the other.

§ 103. Conditions for patentability; non-obvious subject matter

A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

## APPENDIX C

### Clark Patent Claims Sued Upon (9 and 10)

9. In a measuring instrument for exposure to a constituent to be measured, the combination of: a first electrode having a polarographic sensitive electrode surface; means for defining an electrolyte space adjoining said sensitive surface, said means including a membrane permeable to the constituent to be measured, the outer surface of said membrane being exposable to an environment containing the constituent; a second electrode polarographically complementary to said first electrode, both said electrodes being positioned on the side of said membrane opposite the side exposed to said environment; and electrolyte means providing an ionic solution in said electrolyte space in contact with said sensitive surface and the inner surface of said membrane, and forming an ionic bridge between said first and second electrodes, the volume of said electrolyte space being small to provide a short equilibration time for said electrolyte means and a short time constant in the measurement.

10. In an instrument for measuring a constituent in either a gaseous or liquid environment, the combination of: a polarographic sensing electrode; means defining an electrolyte space immediately adjacent to said sensing electrode, said means including a membrane permeable to said constituent, said membrane separating said electrolyte space from said environment; a body of electrolyte with at least a portion of said electrolyte filling said electrolyte space; and a reference electrode electrically isolated from said sensing electrode except through said electrolyte and positioned on the same side of said membrane as said sensing electrode for contact with said body of electrolyte, said sensing electrode effecting a signal current through said electrolyte and said reference electrode by removal of said constituent from said electrolyte space, said space being of small volume and providing a short diffusion path between said membrane and said sensing electrode for rapid equilibration of said current to changes of said constituent in said environment.